Sn,10/786,084

拒絶理由通知書

特許出願の番号	特願２００２－２６０２２６
起案日	平成１９年　４月２６日
特許庁審査官	天野　宏樹　　９２７２　４Ｖ００
特許出願人代理人	重野　剛　様
適用条文	第２９条第１項、第２９条第２項、第３６条

この出願は、次の理由によって拒絶をすべきものである。これについて意見があれば、この通知書の発送の日から６０日以内に意見書を提出して下さい。

理　由

I.　この出願の下記の請求項に係る発明は、その出願前に日本国内又は外国において、頒布された下記の刊行物１に記載された発明又は電気通信回線を通じて公衆に利用可能となった発明であるから、特許法第２９条第１項第３号に該当し、特許を受けることができない。

II.　この出願の下記の請求項に係る発明は、その出願前日本国内又は外国において頒布された下記の刊行物１～５に記載された発明又は電気通信回線を通じて公衆に利用可能となった発明に基いて、その出願前にその発明の属する技術の分野における通常の知識を有する者が容易に発明をすることができたものであるから、特許法第２９条第２項の規定により特許を受けることができない。

III.　この出願は、明細書の記載が下記1)の点で、特許法第３６条第６項第２号に規定する要件を満たしていない。

IV.　この出願は、明細書の記載が下記2)の点で、特許法第３６条第４項に規定する要件を満たしていない。

記　　（引用文献等については引用文献等一覧参照）

理由Iについて

請求項１、２

引用文献１

（特に、同文献の特許請求の範囲、第３頁７～２０行、第１０頁１５～１９行、第１２頁８～２１行及び図１、図２ａ、図２ｂ）

を参照。

［備考］

引用文献１には、廃水処理プロセスから得られるスラッジを乾燥、熱処理及びペレット成形し、汚染を起こさない無臭の被処理物を製造する装置が記載されており、上部に湿スラッジの入力手段、低板にペレットの出口

手段、が設けられた竪型の容器と、容器内に垂直方向に離間して設けられ、熱媒が内側を循環するようにされた複数の水平な環状プレートと、スラッジペレットをプレート上で移動させるスクレーパ及びその駆動軸を備えること、及び熱媒の温度を１５０℃～３００℃にすることが記載されている。また、プロセスを離れる乾燥したペレットの温度によって、スラッジ原料供給、スラッジペレットの滞留時間、熱媒油の温度等を制御することも記載されている。

なお、引用文献１には日本語のパテントファミリー文献が存在する（特表２００４－５０８９３０号公報、特に【００１３】、【００４９】及び【００５５】を参照。）。

理由IIについて

請求項１、２

引用文献１

引用文献２

（特に、同文献の特許請求の範囲、【００１６】～【００１７】及び【００２７】）

引用文献３

（特に、同文献の特許請求の範囲及び【００１３】）

引用文献４

（特に、同文献の特許請求の範囲、【００２２】及び図４）

引用文献５

（特に、同文献の特許請求の範囲、【００１３】及び図１）

を参照。

［備考］

引用文献２、３に記載されているように、有機性廃棄物からのコンポスト様物の製造において、加熱乾燥後の熱処理温度を１００～２００℃に設定することは当業者が容易になし得ることである。

また、引用文献４、５には、スパイラル状の部材の上で加熱乾燥が行われるようにした竪型の乾燥装置が記載されているから、引用文献１に記載された装置における竪型容器内の加熱手段をスパイラル状にすることは、当業者が容易になし得たことである。そして、本願発明の効果についても格別顕著なものではない。

理由IIIについて

請求項２

1)　温度検知器を設ける位置が「排出口付近」とされ、その測定温度が「所定値」となるように制御すると記載されているが、温度検知器の位置が明確でなく、制御しようとしている温度も明確でないから、温度検知器と温度制

御手段が具体的に廃棄物にどのような内容の処理を加えるためのものなのか理解できない。よって、特許を受けようとする発明が明確でない。

理由IVについて

【００４２】～【００４７】、図２

2)　段落【００４２】～【００４７】の説明及び図２の記載を参酌しても、スパイラル状の伝熱盤を設けた装置の詳細を理解できない。伝熱盤にどこから熱媒油が供給されるのか、伝熱盤は回転するのか、また、回転するとすればどちら向きなのか（原料を下に押し流す向きか、或いは原料を持ち上げる向きか）を理解できないから、本願の発明の詳細な説明は、「スパイラル状に設けられた伝熱盤」を備える装置を用いて実際にコンポスト様物を製造できることを当業者が理解できる程度に十分な説明が記載されていない。

引　用　文　献　等　一　覧

１．国際公開第０２／２４５８５号パンフレット
２．特開２００２－０２８６０８号公報
３．特開２００１－３５３４９９号公報
４．特開２００１－１５３５５５号公報
５．特開平０７－１３６６９６号公報

－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－－

先行技術文献調査結果の記録

・調査した分野

ＩＰＣ第８版

Ｃ０５Ｆ

・先行技術文献

特開平１１－１３２６６３号公報

上記先行技術文献には、上下方向に多段に配設された乾燥槽を有する都市ゴミの乾燥装置が記載されている。

この先行技術文献調査結果の記録は、拒絶理由を構成するものではない。

この拒絶理由通知の内容に関して、お問い合わせまたは面接のご希望がございましたら、下記にご連絡ください。

特許審査第３部　応用有機材料　　天野　宏樹

ＴＥＬ　０３－３５８１－１１０１　（内線　３４８３）

ＦＡＸ　０３－３５８１－１３４３

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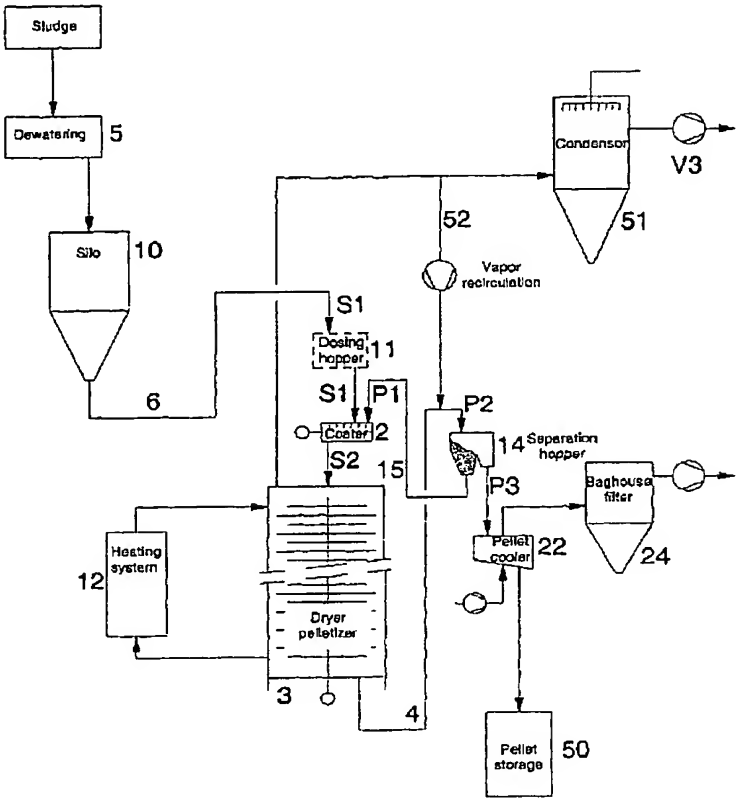
[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR SLUDGE DRYING AND SIMULTANEOUS PELLETIZATION



(57) Abstract: The present invention relates to a process for converting a substantial wet sludge into dried pellets comprising: - bringing the wet sludge into a rolling contact over at least one heated plate, - indirect drying of said rolled wet sludge by a conductive heat transfer from the heated plates to the sludge, and - simultaneously pelletizing the heated sludge which process is performed under an inert atmosphere in order to minimize the explosions and/or combustion risks. The invention further relates to an apparatus for the treatment of sludge into pellets.

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(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Method and apparatus for sludge drying and simultaneous pelletization

Field of the Invention

The present invention relates to an apparatus and a process for the indirect heat drying and simultaneous pelletization, e.g. obtained from a waste water treatment process. In general, the sludge is thermally dried and processed to obtain substantially pathogene free low dust containing pellets, substantially uniform in particle size and uniform in moisture content. Thereafter the pellets are suitable for use as a fertilizer, an additive to a fertilizer, a fuel, etc.

Background of the invention

Waste water treatment creates sewage sludge in large amounts. Raw sewage received in waste water treatment facilities is treated by various known methods which generate the sludge. Thereafter, a problem remains in how to treat and dispose of the sludge in an environmentally safe, energy efficient and economical way. Sludge is presently disposed of in many ways, such as by direct land application of the sludge, composting the sludge, land filling the sludge, ocean filling the sludge, and drying and incinerating the sludge.

Municipal sludge for instance is mostly a liquid containing 2-6% total solids. It typically contains inorganic and organic matter, nutrients such as nitrogen, phosphorous and potassium and traces of various metals. It may also contain pathogens, and, in some instances, constituents such as heavy metals and hazardous organics, depending upon the source of the raw sewage that has been treated.

In the known methods of treating sludge, the sludge is treated to increase its solid content. The sludge can be dewatered by gravity, by mechanically dewatering the sludge, and by thermal treatment of the sludge. The water content of sludge includes intracellular water, capillar water, colloidal water and free water. Free water can generally be separated from the sludge by gravity. The capillar and colloidal water can be removed from the sludge, usually after chemical conditioning, by mechanical means such as centrifuges, belt presses, vacuum filters and the like. Intracellular water, on the other hand, generally needs to be removed by breaking the cell structure down by thermal treatment. When liquid sludge is dewatered or thickened by gravity, the sludge product obtained is 2-6% total solids. The solids content is increased by mechanical dewatering of the sludge to 15-30% total solids. When the liquid sludge is thermally dried, a product of 80-98% total solids is obtained. Just as important, the volume of the sludge decreases as the sludge is processed to increase its solids content.

The type of dewatering process that is selected for a particular waste treatment plant is based upon several considerations. The thermal treatment of sludge has the advantage of the greatest reduction in sludge volume (up to 98%), and also destroys or inactivates pathogenic organisms, rendering the sludge sterile. On the other hand, the thermal treatment of sludge requires special drying equipment and an energy source for generating the heat needed in drying the sludge.

When liquid sludge is merely dewatered and land applied or ocean dumped, then there is a risk of contaminating the land or ocean with pathogens that have not been destroyed or inactivated during the treatment process. Further, if the sludge is not sufficiently dewatered, then an increased material handling problem arises in the transportation of the sludge by truck, barge, train or the like. Therefore, the thermal treatment of sludge has environmental advantages as well as material handling advantages over the disposal of sludge that is merely dewatered or land applied in the liquid sludge state.

Sludge is a solid-liquid waste mixture having a total solid concentration that may range from as low as 10% til more than 50% dry solid content for some industrial sludges. Generally, sludge can flow and can be pumped.

The handling and disposal of sludge has long been considered the most troublesome phase of sewage and industrial waste treatment. With the evolution towards increasing efficient wastewater treatment plants, more difficult to handle sludges are produced. Thus, the past phase of environmental control has become an increasingly difficult problem.

Another aspect of this problem is that with the volume of sludges from the domestic and industrial increasing, the land available for such sludge disposal and public tolerance of environmental pollution is decreasing. This situation has severely constrained the choice of acceptable disposal practices.

In case of mainly organic sludges, previously, attempts have been made to form the sludge into pellets directly but this has been found impossible since the mass has too loose a structure, because of its high (70-80%) water content. Getting below this water content percentage has been found to be impossible in the sludge handling process, since most of the water in the sludge is cell-bound. In addition, it is very sticky, resulting in that any pellets formed quickly stick together and form large aggregates. It is almost impossible to dry out these large lumps to a sufficiently low water content for storage. These masses are also an infection hazard, since they always contain infectious organisms and substances, e.g. salmonella bacteria, different viruses and parasite eggs.

US 5,628,913 discloses a method and an apparatus where pellets can be formed directly, while preventing the formation of aggregates. The latter document discloses

however the use of an extruder through which the dried sludge is urged to a nozzle having an orifice. It is clear that separate pelletizing means are provided in order to obtain said pellets.

The described apparatuses are cumbersome, due to the fact that for example separate pelletizing means need to be provided.

Objects of the invention

An object of the present invention is to overcome the deficiencies of the known sludge treatment systems by using a dryer-pelletizer for sludge that has been dewatered mechanically to dry the sludge by condutive indirect drying and simultaneously pelletization of the dried product inside the dryer-pelletizer so that it is acceptable for use as a fertilizer in pellet form. The pellets do not contain any living organisms, viruses or pathogens so that the risk of contaminating the land, which is present in the direct application of sludge that has not been heat treated, is avoided. Further, as a result of simultaneously pelletizing the dried product to form pellets of a size that can be handled like existing fertilizer pellets, no additional pellet forming apparatus is required that would increase the cost of the system.

A further object of the present invention is to provide non-polluting, odorless process of sludge by an indirect heat method with simultaneous pelletization of the sludge in a multi-stage dryer-pelletizer.

Yet a further object of the present invention is to provide a thermal sludge treatment process and apparatus that is safe and wherein only a negligible volume of odourous uncondensables is produced. To ensure the safety of the process and reduce the volume of uncondensables, no sweep air is allowed, the apparatus is air tight and the inside of the dryer-pelletizer and pellet recirculation system is processed at an oxygen content far below the ignition limits of the dried sludge, by means of inertization by the water vapors generated by the drying process. During start-up the inertization of gaseous medium inside the embodiment is done by injection and evaporation of water to displace the air by inert water vapor.

Yet another object of the invention is to inertisate the pellet recirculation system to eliminate the risk of: pellet glowing and burning, CO and dust explosions, by displacing O_2 by water vapors coming from the drying process. To achieve this inertization part of the water vapor flow generated in the dryer-pelletizer are extracted in front of the condenser and reinjected in the pellet recirculation system at the farest end to flow back into the dryer-pelletizer.

Yet a further object of the present invention is the place of the coater right in front off and on top of the dryer-pelletizer to achieve a monogeneous and not sticky mixture of

died fines coated with a thin layer of wet sludge, together having a moisture content of between 60 to 70% solids.

The dryer-pelletizer feed is preferably kept at a moisture content of between 60 to 70% solids so that a difficult to handle, glue-like sludge phase inside the dryer-pelletizer is avoided. By the process of indirect heat drying of the dewatered sludge, the dried fines are mixed with the dewatered sludge to provide central dry nuclei that are coated by the dewatered sludge and dried to build up the nuclei layer by layer to form the pellets of a desired size, preferably 2-4 millimeters. Pellets are built up layer by layer, and are therefore dried from the inside out. It is further preferable that a supply of dried fines are maintained for start-up of the process after the indirect heat dryer has been shut down for a period of time.

Yet another object to the invention is to guarantee the pearl process, of adding layer by layer of wet sludge to a basis of dried sludge pellets and roll it gently over the heated plates while drying to over 90% dry solid content and killing infectious organisms, although the number of scrapers and scraper arms, to gently roll and pelletise the sludge, can vary with a factor of 1 to 100 between the small and the large embodiments. To achieve the same drying and simultaneous pelletization behavior as well in the large as in the small embodiments, part of the scrapers are mounted to push the drying pellets stream up instead of stream down like the other scrapers. The angle of the scrapers is adjustable and adjusted in a way that the residence time in the embodiment, the collision energy between scrapers and drying pellets, and the number of collisions of a drying pellet with the scrapers can be kept the same independent of the size and drying capacity of the embodiment and independent of the number of scrapers of the embodiment.

Yet another object of the present invention is to control the pellet size by a pellet separation hopper. In the pellet separation hopper the larger fraction of pellets is separated from the fines. The hopper has an pellet input and two pellet outputs. At the input, the pellets are entered with a certain horizontal speed. The first exit in horizontal direction is filled up with the fines which are recirculated into the coater in front of the dryer-pelletizer. The second exit in the horizontal direction is always kept empty and only the sufficient large pellets will get to this exit and represent the end product of the system. The larger pellets are separated because of their higher kinetic energy and the fact that larger pieces roll easier down hill over a slope of pellets. The sizing of the pellets is a result of this horizontal speed and the dimensions of the pellet slope. By choosing the right combination of dimensions and entrance speed for the separation hopper, an on-size, desired pellet size can be obtained as end product. If the client wants to be able to adapt the pellet size to the market, the separation hopper is made with adjustable plates to change the dimensions of the hopper which means changing of the shape, length and/or

the angle of the pellet slope. This hopper can be placed as well at the bottom of the dryer-pelletizer as on top of it. When installed at the bottom of the dryer-pelletizer, the bottom scrapers of the dryer-pelletizer will be responsible for the horizontal speed to enter the pellet separation hopper. When installed at the top of the pelletizer, the horizontal speed can be given by a pellet transport device, preferably a bucket elevator or a disk chain conveyor.

Yet another object of the present invention is to provide an easily operable process whereby no dust is produced and working at a minimum temperature is possible, to result in high quality pellets which are round-shaped and dust-free. To achieve this minimal dust production in the dryer-pelletizer, the speed of the scrapers is limited to a maximum and the pellet separation hopper is sized to lead the little amount of dust together with the undersized pellets back to the coater.

It is an object of the invention to achieve an odorless process for the indirect drying of dewatered sludge and simultaneous pelletization thereof that includes cooling the on-size pellets with air that is subsequently treated to destroy any odor causing substances contained therein. It is further preferable to separate the dust from the air used in cooling the on-size pellets by a fabric filter so that the dust can be added to the fines that are recycled and mixed with the dewatered sludge before being input to the dryer-pelletizer

Yet another object of the present invention is to provide for the small capacity embodiments an apparatus with dimensions such that it can be handled over public roads. For this purpose the small embodiments are built in a container sized frame of 20ft, 30ft or 40ft depending of the evaporation capacity of the embodiment.

Although the present invention has been described with respect to an overall integrated system in accordance with achieving the objects of the invention of providing a nonpolluting, fully automated, and odorless liquid sludge treatment system, alternative apparatus than that disclosed can be substituted in order to achieve the same objectives, without departing from the spirit and scope of the invention.

Definitions

The term "sludge" herein used denotes any product containing both solid and liquid matter, in which the liquid matter can be evaporated by heating up the sludge.

The term "pellet" herein used denotes rounded marble like particles with an average diameter between 0.5mm and 15mm.

The term "dryer-pelletizer" herein used denotes an apparatus in which the wet sludge is dried and simultaneously pelletized.

The term "inert atmosphere, inert gas" herein used denotes means in this field of invention a gas or atmosphere which has no significant exothermal reaction with no sludge, pellets and dust.

The term "scraper" herein used denotes a downwardly positioned element which forces the coated sludge and pellets to roll down stream or up stream on the horizontal hot plates of the dryer-pelletizer.

Summary of the invention

The present invention relates to a process, also referred to as "the pearl process", and to an apparatus to dry and pelletize sludge, with a dry solid content of less than 40%, typically about 25%, in a one step process with respect of the safety of the process and quality of the end product. The sludge is dried in a conductive and indirect heating apparatus to simultaneously dry and pelletize the sludge. The dried product is classified to separate the undersized fraction from the pellets. The end product are pellets with a dry solid content of more than 80%, preferably about 93%, which are then cooled and stored for subsequent use as fertilizer, fuel, etc. The too fine pellet fraction is added to and mixed again with liquid sludge before it is input to the drying and pelletizing device. In order to prevent fire or explosion risk, the apparatus and pellet recirculation system are air tight and kept under a water vapor blanket coming from the drying process. The escape of malodorous gases is prevented by keeping the internal of the drying and pellet recirculating system below atmospheric pressure. The water vapor generated during the drying of the sludge is preferably condensated in a direct condenser and the uncondensables are preferably deodorized in a high temperature combustion zone, a bio filter or an activated carbon filter.

In general the present invention relates to a process for converting a substantial wet sludge into dried pellets comprising:

- bringing the wet sludge into a rolling contact over at least one heated plate,
- indirect drying of said rolled wet sludge by a conductive heat transfer from the heated plates to the sludge, and
- simultaneously pelletizing the heated sludge

which process is performed under an inert atmosphere in order to minimize the explosions and/or combustion risks.

Other preferred embodiments of the process according to the invention comprise one or more features disclosed in claims 2 to 15.

The invention further relates to an apparatus for the treatment of sludge into pellets, comprising:

- input means for the sludge on top of the apparatus,

- pellet exit means at a bottom plate of the apparatus,
- a plurality of vertically spaced-apart horizontal annular plates each having an input and an output for the heating medium circulating inside the heated plates, whereby the heating medium is able to flow from one plate to another by means of a tubing,
- an upright shaft, whereby the shaft is equipped with at least one radial arm disposed above a plate for entraining a multiplicity of scrapers for enabling the movement of the sludge pellets on each plate inwardly or outwardly such that these coated pellets can pass onto the next lower plate for treatment on the plates in cascade,
- an outlet for the vapors produced by the heating of the sludge or pellets on the heated annular plates,
- an air tight housing processed under low oxygen conditions, below 10% oxygen in volume, in order to maintain an inert and fire and explosion safe atmosphere inside the embodiment.

Other preferred embodiments of the apparatus according to the invention comprise one or more features disclosed in claims 17 to 42.

Detailed summary of the invention

The present invention relates a process and method for treating a sludge by transforming it into dried pellets comprising: rolling the wet sludge over one or more hot plates for conductive indirect drying and simultaneously pelletization of the sludge, while keeping the process under an inert atmosphere, inert for explosions and combustion of the pellets, dust and sludge. This inert atmosphere is achieved by using the evaporated vapors as an inert low oxygen containing blanket inside the dryer-pelletizer and pellet recirculation system.

Most commonly the sludge is first coated, in a coater, around dry nuclei, preferably existing of recirculated dried too fine pellets, to facilitate the formation of pellets while drying in the dryer-pelletizer. The, by this process, dried sludge is recirculated several times as fines separated in the separation hopper, building up the pellets layer by layer to a predetermined size, before it is separated off as an on-size pellet in the separation hopper.

The invention provides therefore a method for the continuous drying of sludge comprising: coating of recirculated sludge pellets with a dry solid content of about 80-99% with sludge to be dried, introducing said coated sludge pellets into a dryer-pelletizer at a slightly negative pressure with the exclusion of air, such that the oxygen content in the dryer is lower than 5% by volume, bringing said coated pellets into contact with the outside surfaces of a plurality of hollow and heated annular plates, displacing the coated

pellets on each plate inwardly or outwardly and counter stream such that these coated pellets stay sufficiently long and with the right pellet layer thickness on the plate to obtain a sufficient residence time in the dryer-pelletizer to dry and gently form a round pellet shape while passing onto the next lower plate for treatment on the plates in cascade, evaporizing the liquid contained in said coated pellets, separating the sufficiently sized dried sludge pellet fraction from the not sufficiently sized dried sludge pellets fraction in the separation hopper, and recirculating of the not sufficiently sized dried sludge pellet fraction by transporting them further upwards to coat them again with sludge to be dried, while keeping a low oxygen containing water vapor blanket in the pellet recirculation system by recirculation of water vapors generated by the sludge drying.

The combination of coating and drying and recirculation provides for an excellent mode of operation wherein the sludge is dried efficiently and high quality pellets are resulting therefrom.

Pellets produced according to the present invention can be delivered at a time suitable to agriculture or for other applications, since they are capable of being stored.

The invention further relates to an apparatus for the treatment of sludge comprising coater for the coating of recirculated sludge pellets with a dry solid content of about 80-99% with sludge to be dried and drying means for drying the coated sludge pellets, whereby the drying means comprise a plurality of vertically spaced-apart horizontal annular plates, an upright shaft, upper inlet means and lower outlet means, the shaft having at least one radial arm disposed above each plate for entraining a multiplicity of scrapers for enabling the movement of the coated pellets on each plate inwardly or outwardly such that these coated pellets can pass onto the next lower plate for treatment on the plates in cascade, and heating means for heating the plates, whereby the coater are situated near the upper inlet of the drying means. All kept under a low oxygen containing blanket of vapors from the drying process to avoid explosions and fire.

The apparatus and the process for indirect heat drying and simultaneous pelletization of a liquid waste sludge is shown in figure 1 and the dryer-pelletizer itself in figure 2a and figure 2b. The system is fully integrated to provide an odorless, highly energy efficient process for treating liquid sludge wherein the escape of malodorous gases and the risk of self-ignition of the pellets and dust explosion is minimized, and sterile dry pellets are produced as a fertilizer, fuel, etc.

The drying and pelletizing section receives the dewatered sludge stored in silo 10 in a coater 2 as it is transported 6 from the silo 10 to the coater 2. In the coater 2, the dewatered sludge is mixed with fines obtained from the dry product classifying separation hopper 14, and the mixture is input to dryer-pelletizer 3. Preferably, the moisture content

of the mixture entering S2 the dryer-pelletizer 3 is between 60 and 70% solids in order to avoid a difficult to handle, glue-like sludge phase inside the dryer-pelletizer 3.

The fines that are mixed with the dewatered sludge play an important role in the simultaneous drying and pelletizing process. Each particle of the fines represents a central dry nucleus 38 that is built up layer by layer with the dewatered sludge 34 and dried to form the pellets and other dried material of various sizes. As the mixture of sludge and fines moves through the dryer-pelletizer 3, the layering process is repeated over and over until the product exits P2 the dryer-pelletizer 3. Therefore, the dried product exiting the dryer-pelletizer 3 will be in various shapes and sizes, and will include the pellets that are the desired end product of the process. Since each of the pellets is formed from a dry core, the resultant pellets have a structural stability that withstands subsequent material handling steps without crumbling. The sufficiently sized pellets are separated from the fines in the pellet separation hopper 14 and cooled down in a fluidized bed cooler 22, while the fines are recirculated 15.

According to the present invention there has now been provided a process, a method and an apparatus that would fulfill the inventive object in an excellent manner.

Brief description of the drawings

The invention will now be described in more detail with the aid of a preferred embodiment and with reference to the accompanying drawings, wherein:

figure 1 schematically illustrates an apparatus for carrying out the process and method in accordance with the present invention;

figure 2a and 2b schematically illustrates a preferred embodiment of the conductive and indirect heated plate-type dryer-pelletizer means used in the present invention;

figure 3 schematically illustrates a preferred embodiment of the coater used in the present invention;

figure 4 schematically illustrates a preferred embodiment of a separation hopper used in the method and apparatus of the present invention;

figure 5 schematically illustrates the preferred dimensioning with the accompanying frame for housing an apparatus according to the present invention; and

figure 6 exemplifies schematically a coated sludge pellet.

Detailed description of the drawings

Figure 1 discloses schematically a preferred embodiment of a process and an apparatus according to the present invention. Said apparatus 1 comprises four main components, being a sludge coater 2, drying-pelletizing means 3, pellet recirculation

means 4 and pellet separation means 14. The sludge to be dried may be optionally mechanically dewatered 5 whereby sludge is obtained of 15 til 50% dry solid content. The sludge originating for example from a wastewater treatment plant is further transported to the coater 2 by means of a sludge transport system 6, preferably a sludge pump or horizontal and vertical screw conveyors.

Optionally the dewatered sludge can be stored in a buffer silo 10 for a short time. In the coater 2 the fraction of recirculated dry sludge pellets fines (P1) are intermixed with an incoming fraction of dewatered sludge (S1). The coated pellets 35 with the wet sludge are fed (S2) into the drying means 3.

Optionally a dosing hopper 11 is provided for dosing the fraction dewatered sludge (S1) to the coater 2. The coated pellets fraction is entered (S2) in the drying means 3 on a spiral dividing plate 49 or centrally entered on a dividing cone 47. Dryer-pelletizer means 3 which is producing dry round-shaped pellets in a continuous energy efficient drying and simultaneous pelletization operation.

The characteristics of the obtained pellets are an average diameter of about 1-4 mm and their specific hardness, due to the formation of a pellet layer by layer depending on the number of recirculation cycli. The obtained pellets are suitable for agricultural use, as an auxiliary fuel, etc. Possible agricultural uses are the use as a slow-release fertilizer or soil conditioner.

The energy for the drying means 3 is preferably supplied by a heat carrier 37 as there is the thermal oil system 12 heat. The dried pellets leaving P2 the drying means 3 at a temperature of about 80-110°C are transported upwards in transporting means 4 and/or 15, preferably a bucket elevator or disc chain elevator. A not sufficient sized fraction of the dried pellets are recirculated 15 to the coater 2 via a separation hopper 14. The separation hopper 14 (see also figure 4) is in general a hopper having one inlet 16 and two separate outlets 17, 18. A first part 19 of the separation hopper 14 is substantially full and a second part 20 is substantially empty. Due to the right combination of horizontal kinetic energy of the pellets, the gravitational forces, an inclination surface 21, length and width within the separation hopper 14 the sufficiently sized pellet fraction (P3) falls through the exit 18 out of the drying system. By changing the physical characteristics of the pellet separation hopper 14, the size of the pellets can be changed from sufficiently sized if bigger than 0,5 mm till sufficiently sized if bigger than 10 mm. The fines fraction (P1) which leaves the separation hopper 14 via exit 17 is recycled and sent back to the coater 2 and the drying means 3. The separation hopper 14 is able to make a classification of the on-size dried product fractions. Indeed, the larger particles tend to come out of the system while the smaller ones remain. The pellet separation hopper 14 followed by the pellet dosing means

15, can be placed as well at the exit of the dryer-pelletizer means 3 as right in front of the pellet coater 2.

The end product of the drying and simultaneous pelletization, the sufficiently sized pellet fraction (P3) is optionally cooled preferably in a vibrating fluid bed cooler 22 up to approximately a temperature of 30-50°C and transferred to a pellet storage 50. Part of the vapors extracted from the dryer-pelletizer 3 are recirculated 52 to the pellet recirculation system 4 and/or 15. The energy from the rest of the vapors is recovered in a condensor 51 and preferably used to heat the liquid sludge prior to digestion. The non-condensables (V3) are preferable injected into a burner for a complete thermal destruction, treated in the deodorisation unit of the waste water treatment plant or for the smaller embodiments treated in a biofilter or activated carbon filter. The apparatus according to this preferred embodiment is designed for a continuous operation (24 hours a day, 7 days a week) and is controlled automatically from a (not shown) central dispatch, where all data is stored in a central databank. Although the smaller embodiments can also be operated 16 hours a day, 5 days a week.

The preferably mechanically dewatered sludge needs to be dried further from approximately 15% till 50% dry solid content up to more than 90% dry solid content. The drying system is essentially an conductive indirect contact dryer-pelletizer 3 having 1 up to 25 plates. The diameter of the plates 31 and 33 is preferably from 2 m to over 7,5 m, for example 2000 mm, 3800 mm, 5200 mm, 6200 mm or 7200 mm. When a container-sized device figure 5 would be envisaged, a smaller diameter of 2000 mm is preferred. Preferably thermal oil as a heating medium is used to optimize heat transfer rate. The preferably mechanically dewatered sludge is transported 6 and dosed into the coater 2 where it is thoroughly mixed and coated around the recirculated dry sludge pellet fraction of fines (P1). The coated pellets fall via the sludge inlet 25 in the upper section of the drying means 3 and are evenly spread by the spiral dividing plate 49 by the ranking mechanism 28 or by the top cone 47 and the raking mechanism 28 on the upper plate 27.

Using a, from outside demountable, ranking mechanism 28 and 32 connected to a central rotating shaft 29 the sludge is moved over the upper plate 27 and 33 and pushed over the edge 30, where it falls on a second plate 31. The continuously rotating scraping arms 32 now move the sludge back in the opposite direction of the plate above where it falls on the next lower plate 33 or 31. The wet outside layer 34 of the sludge pellets 35 is dried by contact with the hot plates 31 and 33 with inside their heat carrier 37. In this way, the spherical sludge pellets 35 are brought in contact with the heated plates 31 and 33 in a continuous and smooth way, which guarantees an efficient heat transfer and avoid dust formation.

The multiplicity of scrapers 48 enable the movement of the coated pellets 35 on each plate 31 and 33 inwardly or outwardly, depending on the angle and position of the scrapers 48 on their radial arm 32. Through this engagement the pellets 35 move to a next plate 31 or 33 for further drying. The speed of rotation, the position of the scrapers 48 (height and working angle) are important features which can control the the residence time of the coated pellets 35 in the dryer-pelletizer 3, the pellet layer thickness on the plates 31 and 33 and the speed and efficiency of drying.

Preferably the necessary energy for the drying process is transferred by thermal oil 37 which circulates through the hollow plates 31 and 33 at a temperature range of about 150-300°C, and more preferably 230-260°C. The oil is heated by any burner, preferably a biological and natural gas burner or heated by fluegases of an incineration process. In order to decrease the energy need, a substantial amount of energy can be recovered from the dryer-pelletizer exhaust. The vapors leaving the dryer-pelletizer 3 at a temperature of about 100-160°C, more preferably at about 115-130°C are preferably condensed in a direct condensor 51. The vaporized liquid is withdrawn via the ID fan (V3) from the housing and led to the hollow heat exchange means, condensed, giving up its latent heat energy, and vaporizing the liquid in wet material. The heat released by said condensation heats water from 50-60°C. In general each coated pellet 35 is being recirculated for an average of 4-20 times and provides for a dry solid content of more than 90%. Care is taken that in the dryer-pelletizer means 3 the oxygen content is lower than 5% by volume, preferably lower than 2%. This aspect minimizes fire and explosion risk.

Each time a new layer of wet sludge 34 is coated onto the inner core of the pellet 38, the pellet grows layer by layer, resulting after drying in a hard, and easy to handle granule at the end of the drying process. The obtained dust-free granules have a dry solid content of more than 90% and a chosen average diameter of 0,5 till 10 mm.

For the container sized type of the apparatus a preferred embodiment of the invention is depicted in figure 5 whereby a frame 39 is provided around the complete apparatus having the outside dimensions suitable for public road transport. The pellet separation hopper 14 in this embodiment is integrated in the bottom of the drying means 3 which provides for a more simple construction and a further guarantee for providing a safe atmosphere for the storage of the hot pellets. In said embodiment preferably shaft 29 driving means are integrated at the top of the dryer-pelletizer 3 which further simplifies the construction. In the dryer-pelletizer means 3 adjustable blades or scrapers 48 are preferred to control the residence time. Frame 39 consists essentially of container-sized interlinked horizontal and vertical beams including standard container corners. Four stamps 43 are attached on a floor element 44. If necessary, a separate container 45 can be provided for housing of for example the burner unit and control panels.

The coater 2 wherein sludge S1 and pellet fines P2 are intermixed such that the dried pellet fines are coated with a wet sludge forming the outer layer 34 of said pellet by means of a horizontal shaft 41 carry blades or scrapers 42. Along the horizontal shaft 41 several material engaging blades 42 are provided which each have a separate axe 43. Rotation of the shaft 41 provides for an efficient coating of the pellets 35.

CLAIMS

1. A process for converting a substantial wet sludge into dried pellets comprising:
   - bringing the wet sludge into a rolling contact over at least one heated plate,
   - indirect drying of said rolled wet sludge by a conductive heat transfer from the heated plates to the sludge, and
   - simultaneously pelletizing the heated sludge

   which process is performed under an inert atmosphere in order to minimize the explosions and/or combustion risks.
2. A process according to claim 1, wherein said atmosphere is maintained in an underpressure condition to the ambient air In order to facilitate the evacuation and optionally the treatment of malodorous gases originating from the evaporation of the liquid present in the sludge and avoiding polluting of the ambient air.
3. A process according claims 1 or 2, comprising further a recirculation step of at least a of part of the vapor originating from the evaporation of the liquid contained in the wet sludge for maintaining the atmosphere inert.
4. A process according to any of previous claims 1 to 3, comprising further the step of introducing water in the process, said water its under the process able to be evaporated as an inert vapor or the step of directly introducing an inert gas in the process.
5. A process according to any of claims 1 to 4, further comprising a coating step of the wet sludge around a nuclei in order to facilitate the formation of pellets.
6. A process according to any of the previous claims 1 to 5, further comprising a recirculation step of at least a portion of the dried pellets, said portion is preferably coated by wet sludge and further dried.
7. A process according to any of the previous claims 1 to 6, further comprising a separation step of the dried pellets into too fine pellet fractions and on-size pellet fractions, whereby the on-size pellet fraction is the desired end product of the process and whereby the too fine fraction is recirculated and preferably further coated by wet sludge and further dried.
8. A process according to any of the previous claims 1 to 7, wherein the residence time of the coated sludge pellets on the heated plates is controllable by the adjustment of the displacement means.
9. A process according to any of the previous claims 1 to 8, wherein the residence time of the sludge to be dried, the layer thickness thereof and the amount and impact of the forced displacements of the coated sludge pellets is controllable by the adjustment of the displacement means.

10. A process according to any of the previous claims 1 to 9, wherein the sludge feed is controlled by the temperature of the dried pellets leaving the process.

11. A process according to any of previous claims 1 to 10, wherein the dry solid content of the pellets leaving the process is controlled by the temperature of the pellets, while the heat input is controlled by thermal oil circulating through the plates thereby monitoring a temperature of between 200°C and 280°C.

12. A process according to any of previous claims 1 to 11, further comprising a vapor recirculation system injecting these vapors into the pellet recirculation system to inertizate the pellet recirculation system.

13. A process according to any of previous claims 1 to 12, wherein the plates are heated by a heat medium circulating inside the plates having a temperature of 150-300°C, preferably 230-260°C.

14. A process according to any of previous claims 6 to 13, further comprising the cooling of the on-size pellets as the desired end product of the preferably within a vibrating fluidized bed.

15. A process according to any of previous claims 6 to 14, wherein the average recirculation of the fines is 4 to 20 times, before the fine pellets become on-size pellets, leaving the process.

16. Apparatus for the treatment of sludge into pellets, comprising:

- input means for the sludge on top of the apparatus,
- pellet exit means at a bottom plate of the apparatus,
- a plurality of vertically spaced-apart horizontal annular plates each having an input and an output for the heating medium circulating inside the heated plates, whereby the heating medium is able to flow from one plate to another by means of a tubing,
- an upright shaft, whereby the shaft is equipped with at least one radial arm disposed above a plate for entraining a multiplicity of scrapers for enabling the movement of the sludge pellets on each plate inwardly or outwardly such that these coated pellets can pass onto the next lower plate for treatment on the plates in cascade,
- an outlet for the vapors produced by the heating of the sludge or pellets on the heated annular plates,
- an air tight housing processed under low oxygen conditions, below 5% oxygen in volume, in order to maintain an inert and fire and explosion safe atmosphere inside the embodiment.

17. Apparatus according to any of the previous claim 16, wherein further recycle means are provided for recirculating the produced vapors.

18. Apparatus comprising the apparatus of claims 16 or 17, further comprising a coater on top of the apparatus for the coating of the wet sludge around dry nuclei further comprising feeding means for feeding the so coated sludge to apparatus, said coater comprises at his upper side of an dry nuclei pellet input and a sludge input, mixing arms, driving means to drive the mixing arms able to mix the nuclei and the sludge and at the down stream side having a coated sludge outlet to the apparatus.
19. Apparatus according to any of the previous claims 16 to 18, further comprising a static pellet separation hopper able to separate on-size pellets from fine pellets as a result of the horizontal speed of the pellet at the input of the separation hopper and the dimensions of the pellet slope in the hopper by choosing suitable dimensions and entrance speed in order to obtain the desired pellet on-size as end product.
20. Apparatus according to any of the previous claims 16 to 19, further comprising recirculating means for recirculating the fines pellets.
21. Apparatus according to any of the previous claims 16 to 20, wherein the recirculation means consist of a thermally insulated and traced disc chain conveyer or a bucket elevator.
22. Apparatus according to any of the previous claims 16 to 21, wherein shaft driving means of the dryer pelletizer are provided at the upper side thereof and wherein the coated sludge input is placed excentrically in the roof of the dryer-pelletizer and a spiral sludge dividing plate is used to spread the coated sludge homogeneously over the upper heated plate. Using the spiral plate and the drive at the upper side of the dryer-pelletizer to obtain a smaller and more economically embodiment.
23. Apparatus according to any of the previous claims 16 to 21, wherein shaft driving means are provided underneath the dryer-pelletizer while the coated sludge input is placed in the center in the roof of the dryer-pelletizer and a conical pellet dividing plate is used to spread the coated pellets homogeneously over the upper heated plate.
24. Apparatus according to any of previous claims 16 to 23, wherein the roof of the apparatus is made flat.
25. Apparatus according to any of previous claims 16 to 24, wherein the scraper arms or part of the scraper arms are wearable parts, from outside the dryer-pelletizer.
26. Apparatus according to any of previous claims 16 to 25, wherein the bottom is flat and the bottom scrapers are adapted in a way to guide the dried pellets to the exit of the dryer-pelletizer.
27. Apparatus according to any of previous claims 16 to 26, wherein the angle of the up stream pushing scrapers is adjustable.
28. Apparatus according to any of previous claims 16 to 27, wherein the scrapers comprise down stream pushing scrapers and up stream pushing scrapers whereby the

relative position of the down stream pushing scrapers to the up stream pushing scrapers is adapted to have full control on the residence time, the layer thickness and the amount and impact of the forced displacements of the coated sludge pellets, independent of the amount of plates and scrapers in the complete dryer-pelletizer.

29. Apparatus according to any of previous claims 16 to 28, wherein the angle of the scrapers is adjustable in a way that the combination of the down stream and up stream pushing scrapers can be positioned to give a full positive displacement on the pellets till a zero displacement and full expulsion.

30. Apparatus according to any of previous claims 16 to 29, wherein the scrapers at the inner circle of the plate are smaller than those at the outer circle of the plate to get the same relative displacement of the pellets on both circles.

31. Apparatus according to any of the previous claims 16 to 30, wherein separation means are provided separating the dried pellets, leaving through the lower outlet of the dryer-pelletizer, into a sufficiently sized dried sludge pellet fraction and a not sufficiently sized dried sludge pellet fraction, said separation means consist essentially of a hopper having one inlet and two outlets and in which hopper a separation wall is provided, separating the two outlets.

32. Apparatus according to claim 31, wherein the separation wall is adjustable to control the size of the separated end product.

33. Apparatus according to claim 31 or 32, wherein the side walls of the hopper are adjustable to control the size of the separated end product.

34. Apparatus according to any of the previous claims 16 to 33, further comprising a dosing hopper positioned near the inlet of the coater for dosing the sludge to be dried for delivering them in the coater.

35. Apparatus according to any of the previous claims 16 to 34, further comprising a pellet dosing screw positioned under the outlet of the fines of the pellet separation hopper for dosing the pellets to be coated for delivering them in the coater

36. Apparatus according to any of the previous claims 16 to 35, further comprising cooling means for the cooling of the dried pellets.

37. Apparatus according to the previous claim 36, wherein the cooling means consist essentially of a vibrating fluidized bed cooler.

38. Apparatus according to any of the previous claims 16 to 37, such that the diameter of the annular heated plates is between 1500mm and 7500mm.

39. Apparatus according to any of the previous claims 16 to 38, further comprising a frame supporting and surrounding the apparatus.

40. Apparatus according to any of the previous claims 16 to 39, such that the outer dimension of the supporting frame of the apparatus is equal to the outer dimension of

a standard transport container of 20, 30 or 40 feet such that is suitable for public transport.

41. Apparatus according to any of the previous claims 16 to 40, such that the supporting structure of the dryer-pelletizer to the container sized frame is adapted to fixate the dryer pelletizer as well in vertical operation position as in horizontal transport position allowing thermal expansion in operation position.

42. Apparatus according to any of the previous claims 16 to 41, such that the guiding-supporting structure of the plates can be fixated for transport means and released during normal operation to allow a thermal expansion of the plates.

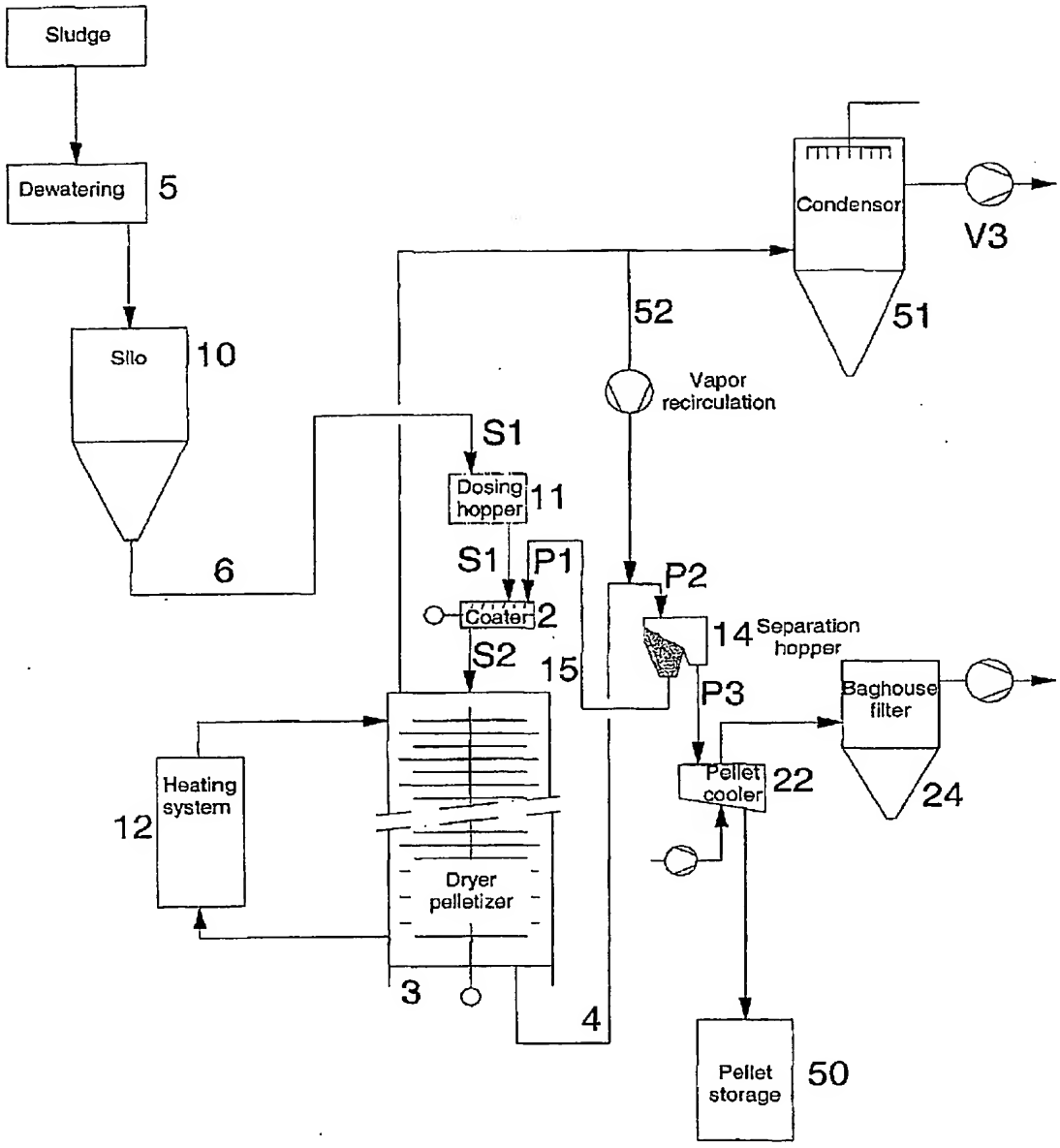
Sludge
Dewatering
5
Silo
10
6
Condensor
V3
51
52
Vapor recirculation
S1
Dosing hopper
11
S1
P1
Coater
2
S2
15
P2
14
Separation hopper
P3
Baghouse filter
24
Pellet cooler
22
Heating system
12
Dryer pelletizer
3
4
Pellet storage
50

Figure 1

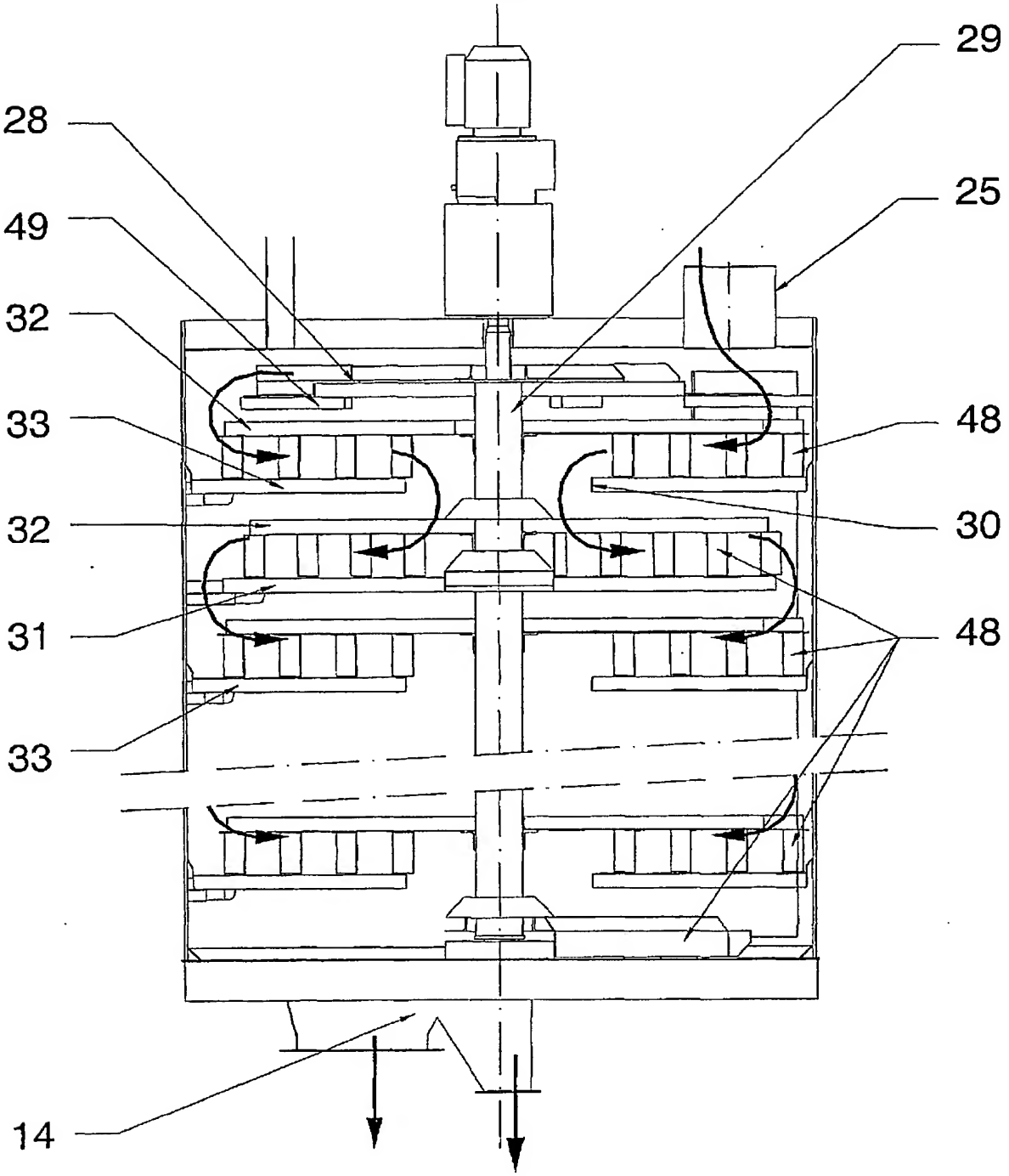

Figure 2a

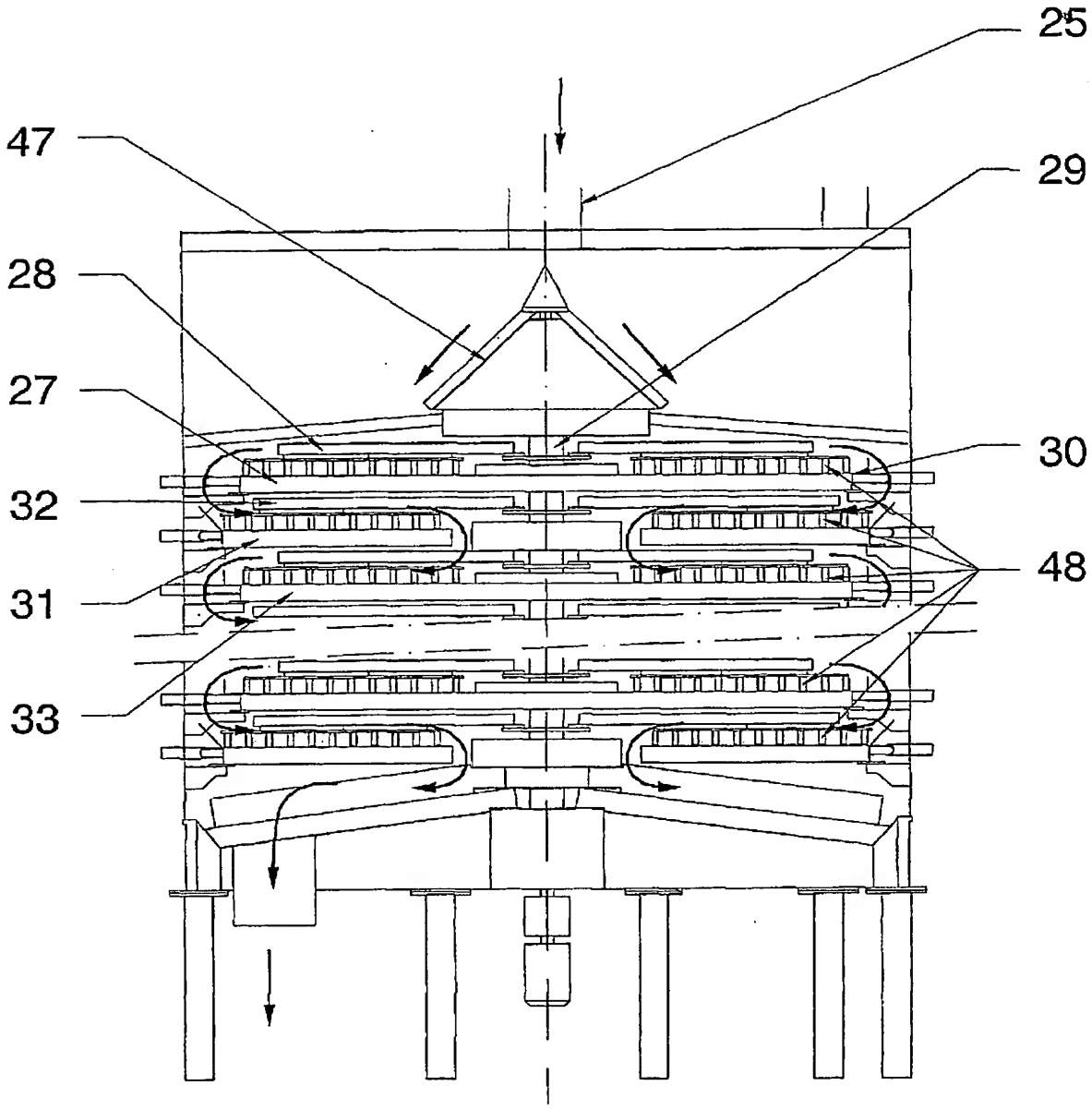

Figure 2b

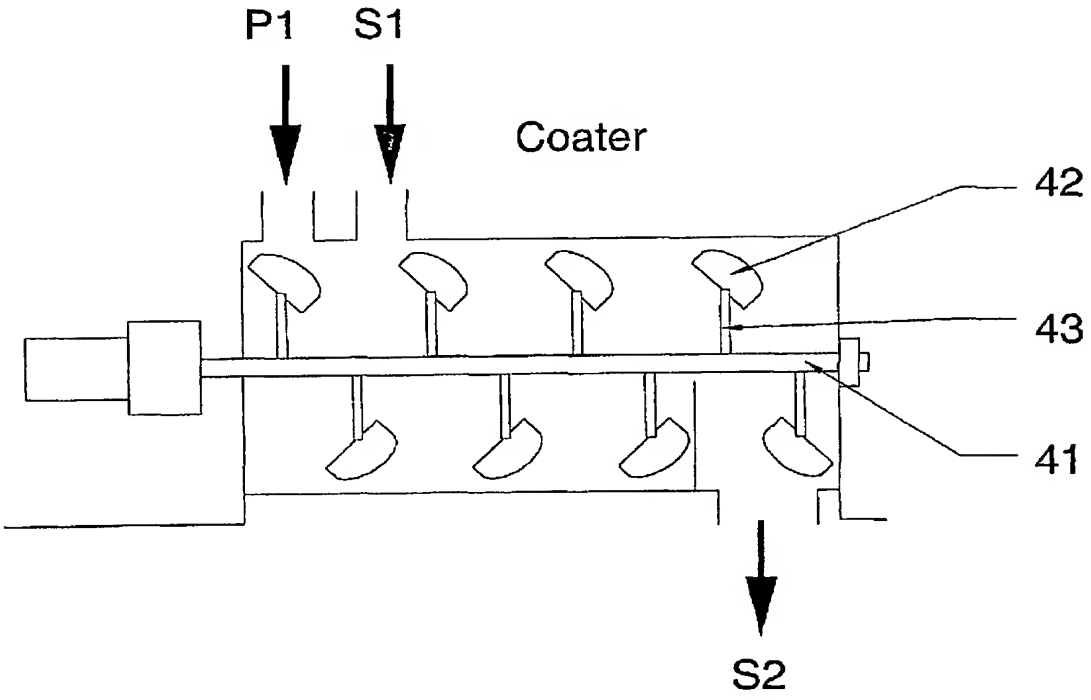

Figure 3

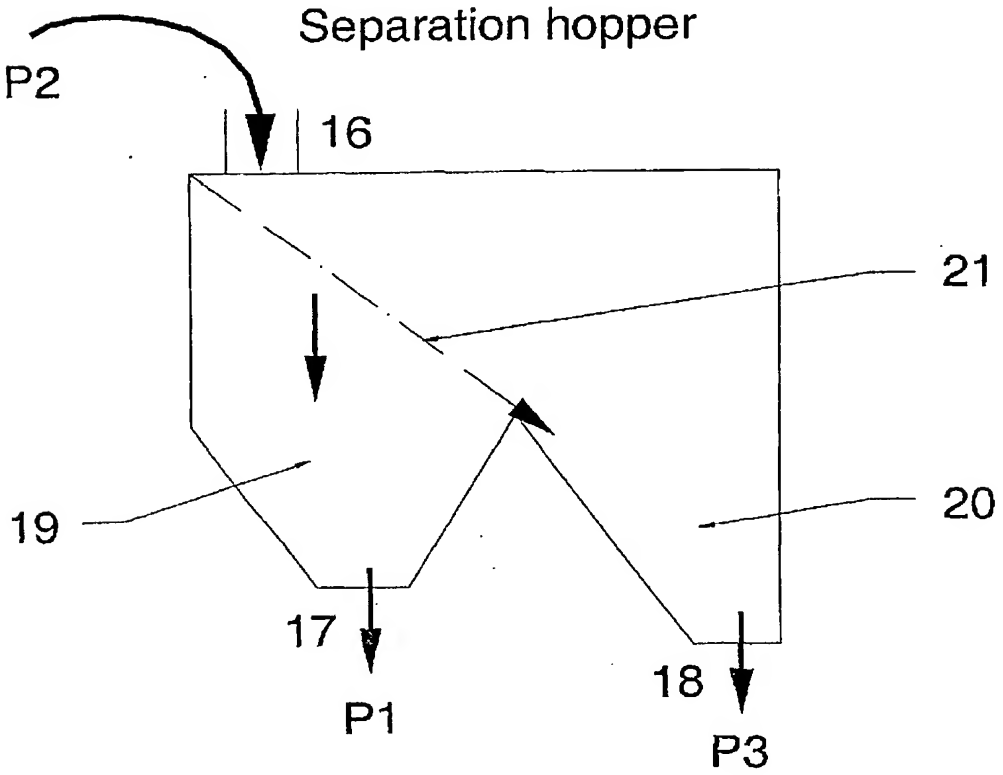

Figure 4

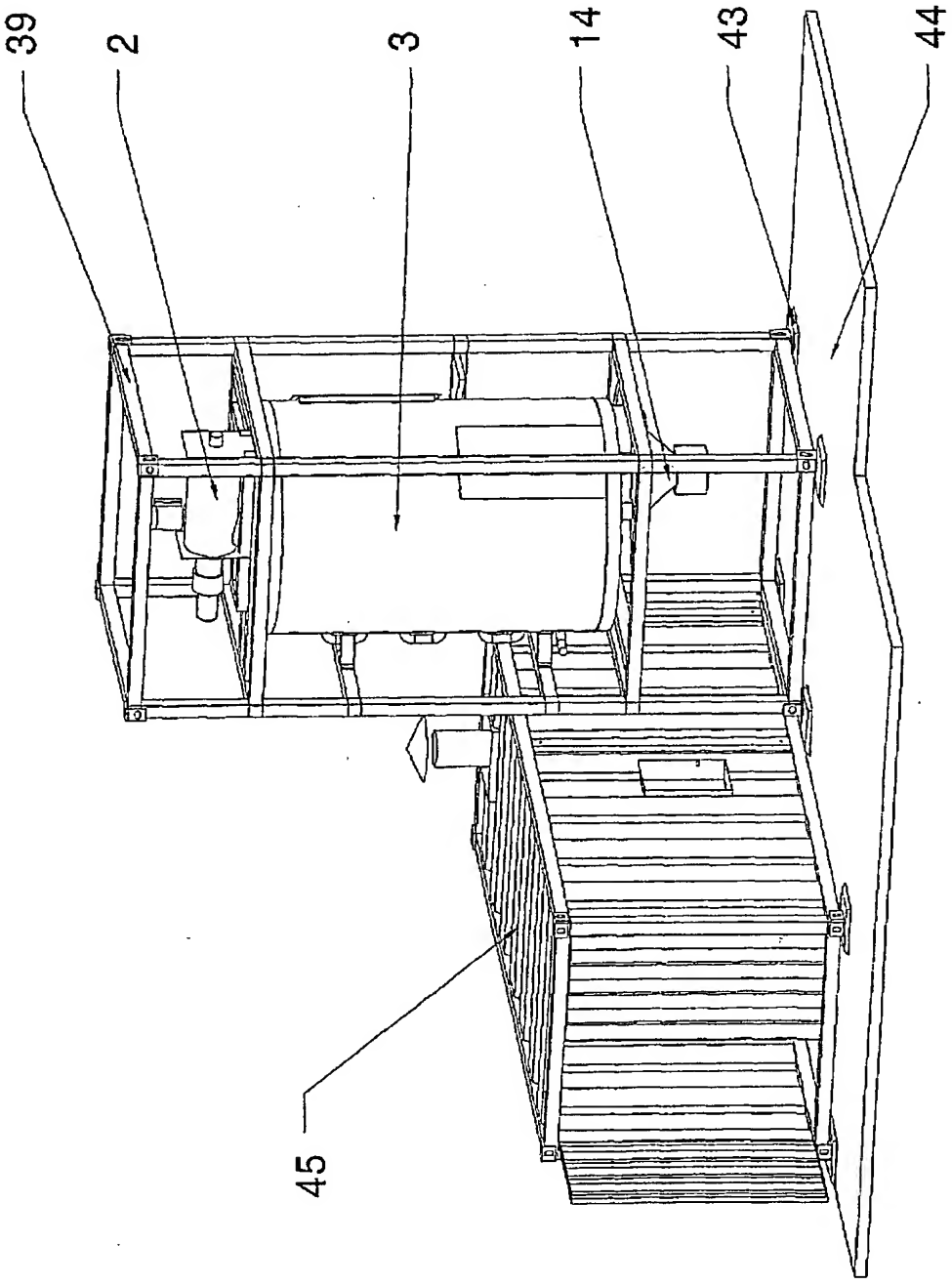

Figure 5

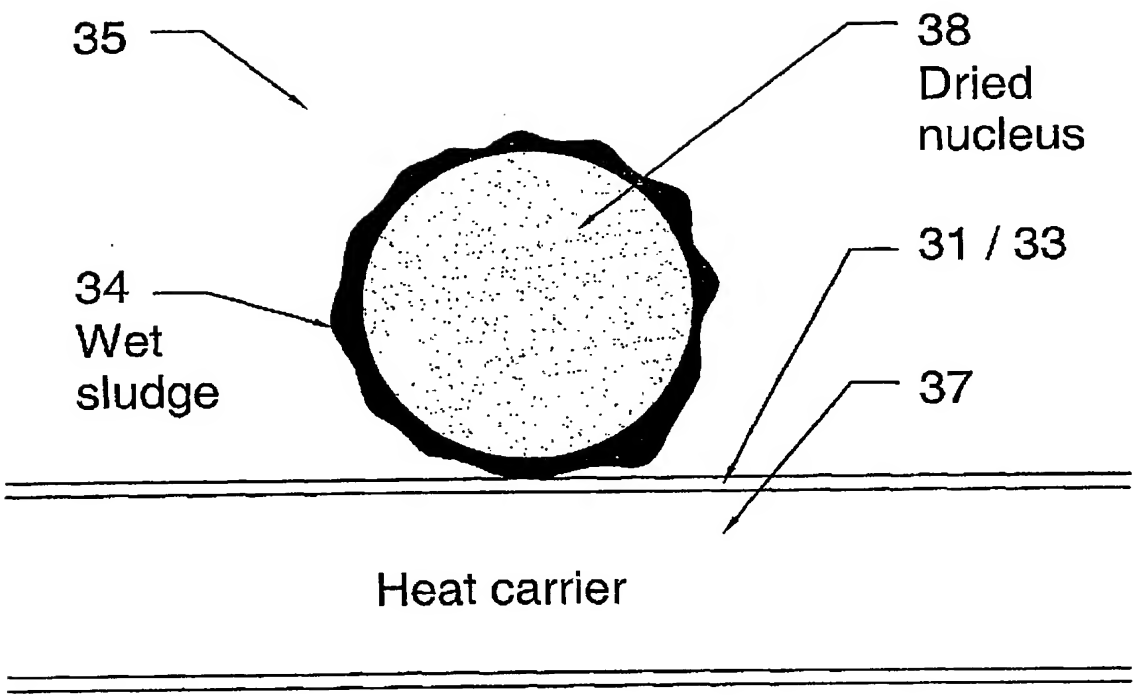

Figure 6

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/EP 01/10951

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F11/12 F26B17/00 B01J2/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F F26B B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 5 069 801 A (GIROVICH MARK J) 3 December 1991 (1991-12-03) column 5, line 1 -column 6, line 65 figures 1,2	1-3,16, 18,20, 23,26,36
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 January 2002	28/01/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Liebig, T

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Interl al Application No
PCT/EP 01/10951

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DE 44 07 536 A (BAUMANN SCHILP LUCIA) 14 September 1995 (1995-09-14) the whole document	1-42

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